MILITARY SPECIFICATION
SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, POWER,
TYPE 2N7372, JANTX, JANTXV, AND JANS

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the detail requirements for PNP, silicon, power transistors for use in high-speed power switching applications. Three levels of product assurance are provided as specified in MIL-S-19500.

1.2 Physical dimensions. See figure 1 (TO-254AA).

1.3 Maximum ratings.

Type	P_T 1/ T_A = +25°C	P_T 2/ T_C = +25°C	V_{CBO}	V_{CEO}	V_{EBO}	I_C	I_C 3/	Reverse pulse 4/ energy	Safe operating area	T_J and T_{STG}
	W	W	V dc	V dc	V dc	A dc	A dc	mJ	See figure 4	°C
2N7372	4	58	100	80	5.5	5.0	10	15		-65 to +200

1/ Derate linearly 22.8 mW/°C for T_A > +25°C.
2/ Derate linearly 331 mW/°C for T_C > +25°C.
3/ This value applies for PW ≤ 8.3 ms, duty cycle ≤ 1%.
4/ This rating is based on the capability of the transistors to operate safely in the unclamped inductive load energy test circuit of figure 1.

1.4 Primary electrical characteristics.

	h_{FE2}	$\|h_{fe}\|$	$V_{BE(SAT)2}$ 1/	$V_{CE(SAT)2}$ 1/	C_{obo}	$R_{\theta JA}$	$R_{\theta JC}$
	V_{CE} = 5.0 V dc I_C = 2.5 A dc	V_{CE} = 5.0 V dc I_C = 500 mA dc f = 10 MHz	I_C = 5.0 A dc I_B = 500 mA dc	I_C = 5.0 A dc I_B = 500 mA dc	V_{CB} = 10 V dc I_E = 0 A dc f = 1 MHz		
			V dc	V dc	pf	°C/W	°C/W
Min	70	7.0					
Max	200		2.2	1.5	250	40	3

1/ Pulse (see 4.5.1)

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Electronics Supply Center, ATTN: DESC-ECT, 1507 Wilmington Pike, Dayton, OH 454444-5270, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 5961

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

MILITARY

MIL-S-19500 - Semiconductor Devices, General Specification for.

STANDARD

MILITARY

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Associated detail specification. The individual item requirements shall be in accordance with MIL-S-19500, and as specified herein.

3.2 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-S-19500.

3.3 Design, construction, and physical dimensions. The design, construction, and physical dimensions shall be as specified in MIL-S-19500, and on figure 1. Methods used for electrical isolation of the terminal feedthroughs shall employ materials that contain a minimum of 90% AL_2O_3 (ceramic). Examples of such construction techniques are metallized ceramic eyelets or ceramic walled packages. The preferred measurements used herein are the metric units. However, this transistor was designed using inch-pound units of measurement. In case of conflicts between the metric and inch-pound units, the inch-pound units shall be ruled.

3.3.1 Lead finish and formation. Lead finish shall be solderable in accordance with MIL-STD-750, MIL-S-19500, and herein. Where a choice of lead finish or formation is desired, it shall be specified in the acquisition requirements (see 6.2). When lead formation is performed, as a minimum, the vendor shall perform 100 percent hermetic seal in accordance with screen 14, of MIL-S-19500.

3.4 Marking. Marking shall be in accordance with MIL-S-19500.

4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500, and as specified herein.

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-S-19500, and as specified herein (see 4.3.2.1).

4.3 Screening (JANTX, JANTXV, and JANS levels). Screening shall be in accordance with MIL-S-19500 (table II), and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see table II of MIL-S-19500)	Measurement	
	JANS level	JANTX and JANTXV levels
1/	Thermal impedance (see 4.3.2)	Thermal impedance (see 4.3.2)
9	I_{CES1} and h_{FE2}	Not applicable
11	Subgroup 2 of table I herein; I_{CES1} and h_{FE2}; ΔI_{CES1} = 100% of initial value or 100 nA dc whichever is greater. Δh_{FE2} = ±20% of initial value.	I_{CES1} and h_{FE2}
12	t = 160 hours	t = 80 hours minimum
13	Subgroup 2 and 3 of table I herein; I_{CES1} and h_{FE2}; ΔI_{CES1} = 100% of initial value or 100 nA dc whichever is greater. Δh_{FE2} = ±20% of initial value.	Subgroup 2 of table I herein; I_{CES1} and h_{FE2}; ΔI_{CES1} = 100% of initial value or 100 nA dc whichever is greater. Δh_{FE2} = ±20% of initial value.

1/ May be performed anytime before screen 9.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows:

$$T_J = 187.5 \pm 12.5°C,\ V_{CE} \geq 20\ V\ dc,\ T_A \leq 100°C$$

4.3.2 Thermal impedance ($Z_{\theta JX}$ measurements). The $Z_{\theta JX}$ measurements shall be performed in accordance with MIL-STD-750, method 3131. The maximum limit (not to exceed the Group A, Subgroup 2 limit) for $Z_{\theta JX}$ in screening (table II of MIL-S-19500) shall be derived by each vendor by means of statistical process control. When the process has exhibited control and capability, the capability data shall be used to establish the fixed screening limit. In addition to screening, once a fixed limit has been established, monitor all future sealing lots using a random five piece sample from each lot to be plotted on the applicable X, R chart. If a lot exhibits an out of control condition, the entire lot shall be removed from the line and held for Engineering evaluation and disposition.

4.3.2.1 Thermal impedance ($Z_{\theta JX}$ measurements) for initial qualification or requalification. The $Z_{\theta JX}$ measurements shall be performed in accordance with MIL-STD-750, method 3131 (read and record data $Z_{\theta JX}$). $Z_{\theta JX}$ shall be supplied on one lot (500 devices minimum and a thermal response curve shall be submitted). Twenty two of these samples shall be serialized and provided to the qualifying activity for correlation prior to shipment of parts. Measurements conditions shall be in accordance with 4.4.1.

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-S-19500, and as specified herein.

current is for a maximum allowable case temperature of 85°C and two electrical

1/ This average on-state

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-S-19500, and table I herein. The following test conditions shall be used for $Z_{\theta JX}$, end point measurements: $Z_{\theta JX}$ = 3.1°C/W.

a. I_H - 10 mA.
b. V_{CE} measurement voltage - - - - - - - - - - - - - 20 V (same as V_H).
c. I_H collector heating current - - - - - - - - - - - 1 A (minimum).
d. V_H collector-emitter heating voltage - - - - - - - 20 V (minimum).
e. t_H heating time - - - - - - - - - - - - - - - - - 100 ms.
f. t_{MD} measurement delay time - - - - - - - - - - - 50 µs to 80 µs.
g. t_{SW} sample window time - - - - - - - - - - - - - 10 µs (maximum).

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in tables IVa and IVb of MIL-S-19500. Electrical measurements (end points) and delta requirements shall be in accordance with the applicable steps and footnotes of table I, group A, subgroup 2 herein except $Z_{\theta JX}$ shall be performed after Intermittent Life only.

4.4.2.1 Group B inspection, table IVa (JANS) of MIL-S-19500.

Subgroup	Method	Condition
B3	2037	Test condition A
B4	1037	V_{CB} = 10 V dc minimum; P_T = 2.5 W at T_A = room ambient as defined in the general requirements of paragraph 4.5 of MIL-STD-750; t_{on} = t_{off} = 3 minutes minimum for 2,000 cycles. No heat sink or forced air cooling on the devices shall be permitted.
B5	1027	V_{CB} = 20 V dc, T_J = 275°C ±5°C for 96 hours. Adjust P_T adjusted as required by the chosen T_A to give average lot T_J = +275°C. Marking legibility requirements shall not apply.
B6	3131	See 4.5.2.

4.4.2.2 Group B inspection, table IVb (JANTX and JANTXV) of MIL-S-19500.

Subgroup	Method	Condition
B3	1037	V_{CB} = 10 V dc minimum; P_T = 2.5 W at T_A = room ambient as defined in the general requirements of paragraph 4.5 of MIL-STD-750; t_{on} = t_{off} = 3 minutes minimum for 2,000 cycles. No heat sink or forced air cooling on the devices shall be permitted.
B5	3131	See 4.5.2.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table V of MIL-S-19500. Electrical measurements (end points) and delta requirements shall be in accordance with the applicable steps and footnotes of table I, group A, subgroup 2 herein except $Z_{\theta JX}$ shall be performed after Intermittent Life only.

4.4.3.1 Group C inspection, table V of MIL-S-19500.

Subgroup	Method	Condition
C2	2036	Tense: test condition A; weight 10 pounds ±5 ounces; time 15 seconds. Bend strength: test condition F; bending stress 2 pounds, time 15 seconds
C6	1026	V_{CB} = 40 V dc ±1 V dc, T_A = room ambient as defined in the general requirements of paragraph 4.5 of MIL-STD-750. P_T = 2 W, 1,000 hours

4.4.4 Group E inspection. Group e inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VII of MIL-S-19500. Electrical measurements (end points) and delta requirements shall be in accordance with the applicable steps and footnotes of table I, group A, subgroup 2 herein, except I_{eJX} is not required.

4.4.4.1 Group E inspection, table VII of MIL-S-19500.

Subgroup	Method	Condition	Sampling Plan
E1	1051	500 cycles	22 devices, c = 0
E2	1039	Condition A, 500 hours	22 devices, c = 0
E3		Not applicalbe	
E4	3131	See 4.4.1	10 devices, c = 0

4.5 Method of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows:

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

4.5.2 Thermal resistance. Thermal resistance measurements shall be conducted in accordance with test method 3131 of MIL-STD-750. The following details shall apply:

a. Collector current magnitude during power application shall be 2 A dc.

b. Collector to emitter voltage magnitude shall be 10 V dc.

c. Reference temperature measuring point shall be the case.

d. Reference point temperature shall be 25°C ≤ T_R ≤ 75°C and recorded before the test is started.

e. Mounting arrangement shall be with heat sink to header.

f. Maximum limit of $R_{\theta JC}$ shall be 3.0°C/W.

4.5.3 Inspection conditions. Unless otherwise specified in MIL-S-19500 or herein, all inspections shall be conducted at a case temperature (T_C) of +25°C ±3°C.

4.5.4 Group B accelerated life test. This test shall be conducted using one of the two options listed herein (a, b, c) with the following conditions applying to all options: V_{CB} = 30 V dc; 96 hours minimum; T_J = +275°C.

a. P_T = 2.5; P_T adjusted to give a lot average of T_J = +275°C with T_A = +125°C ±25°C.

b. T_A = +25°C ±3°C with P_T adjusted to give a lot average of T_J = +275°C.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical examination	2071					
Subgroup 2						
Thermal impedance	3131	See 4.4.1			3.1	°C/W
Collector to emitter breakdown voltage	3011	Bias condition D; I_C = 100 mA dc; I_B = 0; Pulsed (see. 4.5.1)	$V_{(BR)CEO}$	80		V dc
Collector to emitter cutoff current	3041	Bias condition C V_{CE} = 60 V dc; V_{BE} = 0	I_{CES1}		1.0	µA dc
Collector to emitter cutoff current	3041	Bias condition C V_{CE} = 100 V dc; V_{BE} = 0	I_{CES2}		1.0	mA dc
Collector to emitter cutoff current	3041	Bias condition D V_{CE} = 40 V dc; I_B = 0	I_{CEO}		50	µA dc
Emitter to base cutoff current	3061	Bias condition D V_{EB} = 4 dc; I_C = 0	I_{EBO1}		1.0	µA dc
Emitter to base cutoff current	3061	Bias condition D V_{EB} = 5.5 dc; I_C = 0	I_{EBO2}		1.0	mA dc
Forward-current transfer ratio	3076	V_{CE} = 5.0 V dc; I_C = 50 mA dc; Pulsed (see 4.5.1)	h_{FE1}	50		
Forward-current transfer ratio	3076	V_{CE} = 5.0 V dc; I_C = 2.5 A dc; Pulsed (see 4.5.1)	h_{FE2}	70	200	
Forward-current transfer ratio	3076	V_{CE} = 5.0 V dc; I_C = 5.0 A dc; Pulsed (see 4.5.1)	h_{FE3}	40		
Base to emitter non-saturated voltage	3066	Test condition B; V_{CE} = 5.0 V dc I_C = 2.5 A dc Pulsed (see 4.5.1)	V_{BE}		1.45	V dc
Base to emitter saturated voltage	3066	Test condition A; I_C = 2.5 A dc I_B = 250 mA dc Pulsed (see 4.5.1)	$V_{BE(SAT)1}$		1.45	V dc

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 2 - Continued						
Base to emitter saturated voltage	3066	Test condition A; I_C = 5.0 A dc, I_B = 500 mA dc, Pulsed (see 4.5.1)	$V_{BE(SAT)2}$		2.2	V dc
Collector to emitter saturated voltage	3071	I_C = 2.5 A dc; I_B = 250 mA dc; Pulsed (see 4.5.1)	$V_{CE(sat)1}$		0.75	V dc
Collector to emitter saturated voltage	3071	I_C = 5.0 A dc; I_B = 500 mA dc; Pulsed (see 4.5.1)	$V_{CE(sat)2}$		1.5	V dc
Subgroup 3						
High-temperature operation		T_A = +150°C				
Collector to emitter cutoff current	3041	Bias condition A; V_{CE} = 60 V dc, $V_{BE(OFF)}$ = +2 V dc	I_{CEX}		500	µA dc
Low-temperature operation		T_A = -55°C				
Forward-current transfer ratio	3076	V_{CE} = 5.0 V dc; I_C = 2.5 A dc; Pulsed (see 4.5.1)	h_{FE4}	25		
Subgroup 4						
Common-emitter, small-signal short-circuit forward-current transfer ratio	3206	V_{CE} = 5 V dc; I_C = 100 mA dc; f = 1 kHz	h_{fe}	50		
Magnitude of common-emitter, small-signal short-circuit forward-current transfer ratio	3206	V_{CE} = 5 V dc; I_C = 500 mA dc; f = 10 MHz	$\lvert h_{fe} \rvert$	7		
Open circuit output capacitance	3236	V_{CB} = 10 V dc; I_E = 0; 100 kHz ≤ f ≤ 1 MHz	C_{obo}		250	pf
Switching time		I_C = 5 A dc; I_{B1} = 500 mA dc	t_{on}		0.5	µs
		I_{B2} = -500 mA dc	t_s		1.4	µs
		$V_{BE(off)}$ = 3.7 V dc	t_f		0.5	µs
		R_L = 6 Ω; (see figure 2)	t_{off}		1.5	µs

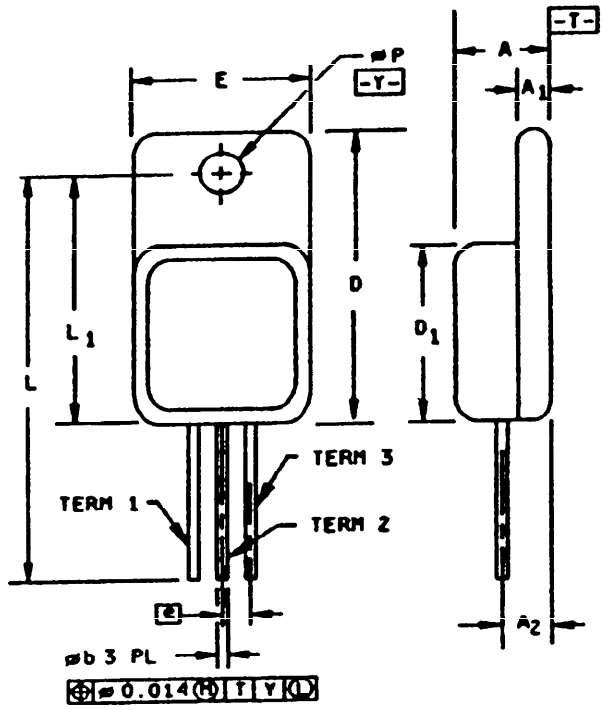
See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 5						
Safe operating area (continuous dc)	3055	Pre-pulse condition for each test: V_{CE} = 0 I_C = 0 T_C = +25°C Pulse condition for each test: t_p = 1 second 1 cycle T_C = +25°C (see figure 4)				
Test 1		V_{CE} = 12 V dc I_C = 5 A dc				
Test 2		V_{CE} = 32 V dc I_C = 1.5 A dc				
Test 3		V_{CE} = 80 V dc I_C = 100 mA dc				
Safe operating area (unclamped inductive)	3053	T_C = +25°C; R_{BB1} = 10 ohms; R_{BB2} = 100 ohms L = 0.3 mH R_L = 0.1 ohms V_{CC} = 10 V dc V_{BB1} = 10 V dc V_{BB2} = 4 V dc I_{CM} = 10 A dc (see figure 3)				
Electrical measurements		Table I, group A, subgroup 2				
Subgroups 6 and 7						
Not applicable						

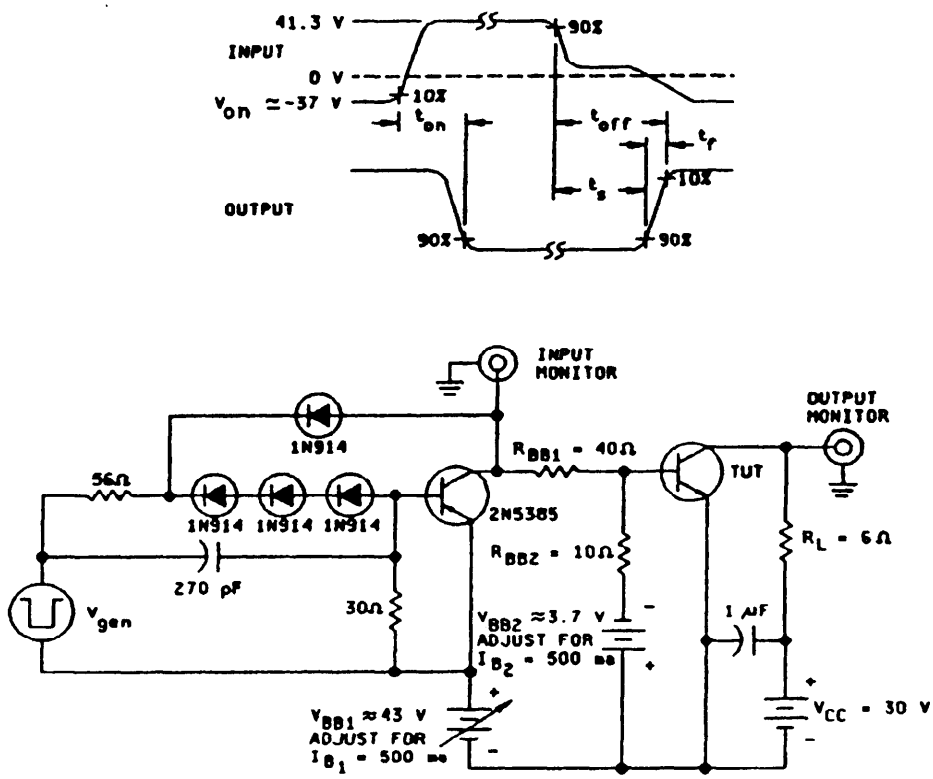
1/ For sampling plan, see MIL-S 19500.

Ltr	Dimensions			
	Millimeters		Inches	
	Min	Max	Min	Max
A	6.32	6.60	.249	.260
A_1	1.02	1.27	.040	.050
A_2	3.81 BSC		.150 BSC	
D	20.07	20.32	.790	.800
D_1	13.59	13.89	.535	.545
e	3.81 BSC		.150 BSC	
E	13.59	13.89	.535	.545
L	30.35	31.37	1.195	1.235
L_1	16.89	17.40	.665	.685
ϕP	3.53	3.78	.139	.149
ϕb	0.89	1.43	.035	.045
Term 1	Base			
Term 2	Collector			
Term 3	Emitter			



NOTES:
1. Dimensions are in millimeters.
2. Inch equivalents are given for general information only.
3. All terminals are isolated from case.

FIGURE 1. Dimensions and configuration (TO-254AA).



NOTES:
1. V_{gen} is -30 pulse (from 0 V) into a 50 ohm termination.
2. The V_{gen} waveform is supplied by a generator with the following characteristics: $t_r \leq 15$ ns, $t_f = 15$ ns, $Z_{OUT} = 50$ ohm, duty cycle ≤ 2%.
3. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15$ ns, $R_{IN} \geq 10$ MΩ, $C_{IN} \leq 11.5$ pF.
3. Resistors shall be noninductive types.
4. The dc power supplies may require additional bypassing in order to minimize ringing.

FIGURE 2. Switching time test circuit.

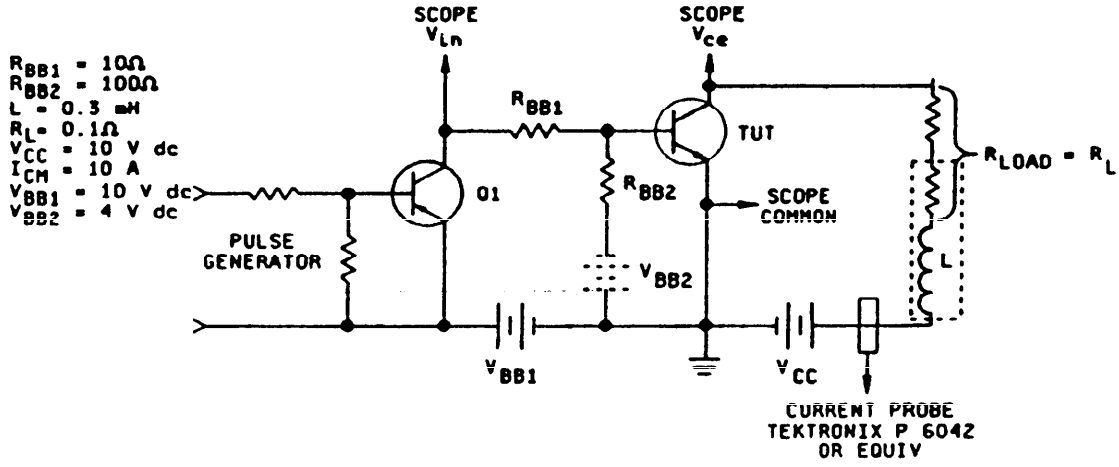


FIGURE 3. Unclamped inductive load energy test circuit.

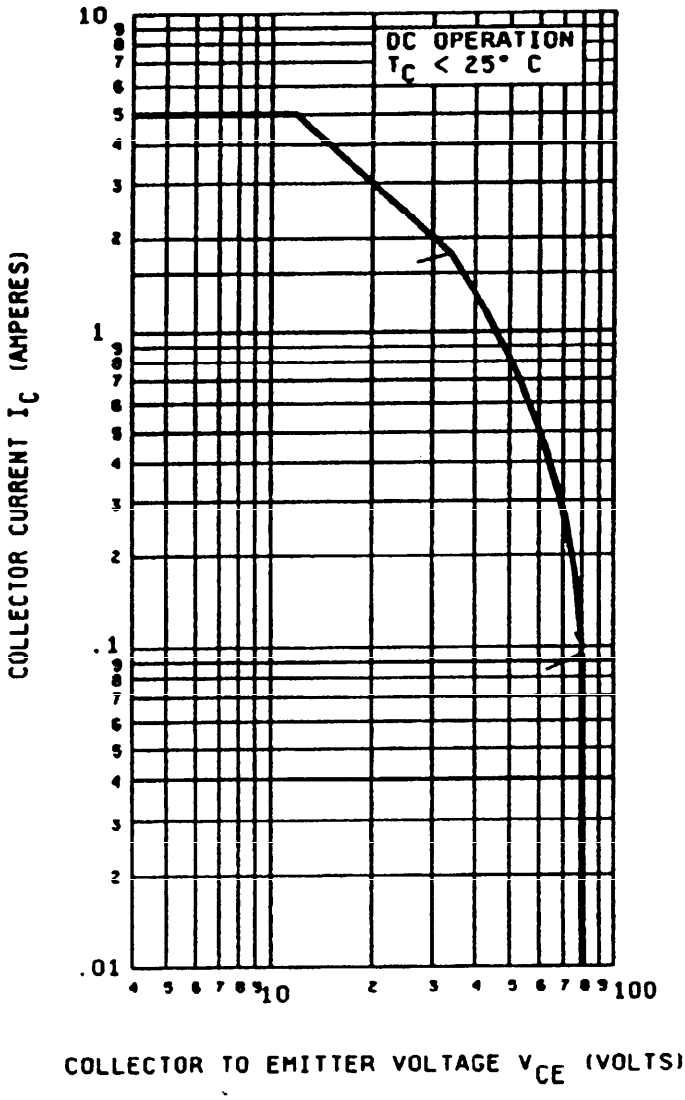


FIGURE 4. Maximum safe operating area.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-S-19500.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Notes. The notes specified in MIL-S-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Lead finish or formation as specified.

b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).

c. Product assurance level and type designation.

6.3 Interchangeability information. MIL-S-19500/612 is a TO-254 package version of MIL-S-19500/535, which is a TO-210 (TO-59) package version. The military 2N7372 contains the same die as the military 2N5005. The MIL-S-19500/612 is preferred over the MIL-S-19500/535 whenever interchangeability is not a problem. For new design use 2N7372. The 2N5005 is inactive for new design.

CONCLUDING MATERIAL

Custodians:
Army - ER
Navy - EC
Air Force - 17
NASA - NA

Review activities:
Army - AR, MI
Air Force - 19, 85, 99

User activities:
Army - SM
Navy - AS, CG, MC, OS
Air Force - 13

Preparing activity:
Navy - EC

Agent:
DLA - ES

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